## REMARKS

The Applicant thanks the Examiner for the detailed comments in the office action mailed August 19, 2005. Claim 15 is amended to correct typographical errors.

**Traversal of 102 Rejection**

The Applicant traverses the rejection of claims 12-15 and 19 under 35 USC 102(e) as being anticipated by U.S. Patent No. 6,775,046 (the "Hill" reference), because the mention of a gold-copper shape memory effect actuator in Hill is not an enabling disclosure. The Applicant can overcome a *prima facie* 102 rejection by proving that the relevant reference is not enabled. *See* Amgen, Inc. v. Hoechst Marion Roussel, Inc., 314 F.3d 1313, 1355, 65 USPQ2d 1385, 1416 (Fed. Cir. 2003).

The Applicant previously submitted a declaration by Peter Jardine (the "Jardine Declaration"). The Jardine Declaration showed that Hill is not enabled, because "...any film made from such an alloy [gold-copper alloy] would not operate as a two-way shape memory effect device." The Applicant is submitting herewith a petition to enter the attached affidavit of L. McD. Schetky, Ph.D., P.E., (the "Schetky Affidavit"), which supports the Jardine Declaration and shows that gold-copper shape memory effect alloys are not enabled.

The Schetky Affidavit is presented to show that a person of ordinary skill in the art would not consider the reference to a gold-copper alloy as being enabled by Hill. There is no known way of using gold copper as a shape memory alloy. It is known by persons of ordinary skill in the art to be impossible. In order to overcome this affidavit, a reference would have to teach how to make a two-way shape memory effect actuator from a gold-copper alloy. Neither Hill nor any other reference teaches this; therefore, the mention of a gold-copper alloy exhibiting a two-way shape memory effect is not enabled. The Applicant respectfully requests the withdrawal of the rejection of claims 12-15 and 19 as anticipated by Hill.

**Traversal of 103 Rejections**

With respect to paragraphs 9-15 of the office action mailed August 19, 2005, the Applicant traverses the rejection of claims 1-16 and 18-21, because the combination of references fails to establish *prima facie* obviousness. To establish *prima facie* obviousness, "three basic criteria must be met." *See* MPEP § 2142. There must be (1) "some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings," (2) "a reasonable expectation of success" and (3) "the prior art reference (or references when combined) must teach or suggest all the claim limitations."

The Hill reference cannot be relied upon to teach a non-titanium-nickel alloy exhibiting a two-way shape memory effect, because the copper-gold alloy taught by Hill is known to persons of ordinary skill in the art to not exhibit shape memory effect. As stated with respect to the traversal of the anticipation rejection based on Hill, Hill fails to teach a reasonable expectation of success for the use of a gold-copper alloy in the making of a two-way shape memory effect film. The Schetky Affidavit clearly shows that no person of ordinary skill in the art would expect a film made of an alloy of gold-copper to exhibit a one-way shape memory effect, much less a two-way shape memory effect. This supports the Jardine Affidavit, which was presented previously. Therefore, the Hill reference, which was relied upon by the Examiner to show that non-titanium-nickel alloys would work in the process of Ho, does not serve this function. As a result, the references fails to establish *prima facie* obviousness, because there is "no reasonable expectation of success." Therefore, claims 1-16 and 18-21 are non-obvious.

Bement is relied upon simply to show that gold-cadmium, copper-zinc-aluminum and copper-nickel-aluminum are know; one-way shape memory alloys that may be produced by a sputter deposition process. As previously presented in the Jardine Affidavit, there are many alloy systems that exhibit one-way shape memory alloy, but the processing conditions for producing a two-way shape memory alloy are not known to a person of ordinary skill in the art without undue experimentation. The disclosure of the present application provides a detailed listing of the processing conditions needed for making two-way shape memory alloys from gold-cadmium, copper-zinc-aluminum,

copper-nickel-aluminum and other alloys in paragraphs 0079 to 0081. Hill, Ho and Bement fail to provide these necessary processing parameters for producing a film comprising substantially no titanium that exhibits the two-way shape memory effect; therefore, none of the cited references teach or suggest all the claim limitations of claims 1-11 and 20, which are drawn to a process for fabricating a shape memory alloy film, comprising the step of "depositing a film of shape memory alloy containing substantially no titanium ... wherein the film is capable of exhibiting a two-way shape memory effect." As a result, claims 1-11 and 20 are non-obvious, because the combination of references fails to establish *prima facie* obvioiusness.

At best, it would be obvious to try to produce shape memory effect actuators comprising films of alloys comprising substantially no titanium. However, the Jardine Affidavit shows that undue experimentation would be necessary; therefore, a person of ordinary skill in the art would not have a reasonable expectation of success. As a result, claims 1-14 and 19-21 are non-obvious, because *prima facie* obviousness cannot be established if a person of ordinary skill in the art fails to have a reasonable expectation of success.

With regard to claims 15-18, the claim was previously amended to include the limitations of "a film formed on a three-dimensional sacrificial scaffold structure or a three-dimensional removable scaffold structure having a three dimensional shape such that the film has a three dimensional shape prior to amy [sic] deformation processing on the film...." None of the cited references teach or suggest the use of such a "three-dimensional sacrificial scaffold structure or a three-dimensional removable scaffold structure." Also, the references fail to teach that such scaffold structures are capable of making a three-dimensional film "such that the film has a three dimensional shape prior to <u>any</u> deformation processing on the film...." As addressed in the previous response, the Ho reference only teaches the production of flat thin films on flat substrates that are then deformed, using deformation processing, to produce a three-dimensional shape memory effect actuator. The Ho reference fails to teach or suggest all of the limitations of claim 15 and claims 16-18, which depend from claim 15; therefore, the Ho reference fails to establish *prima facie* obviousness. None of the other references cited teach or suggest the

limitations missing from the Ho reference; therefore, the combination of the cited references fails to establish *prima facie* obviousness.

**Summary of Remarks Concerning Enablement Rejection**

With respect to the rejection based on 35 USC § 112, first paragraph, the Applicant traverses the rejection of claims 1-21, as being overly broad. According to MPEP 2164.02, a "single working example in the specification for a claimed invention is enough to preclude a rejection which states that nothing is enabled since at least that embodiment would be enabled." Claims 4-8 and 14-20 are based on examples in the specification, which are fully enabled. Claim 15 includes within its scope the working example shown in Figs. 13a and 13b, which is briefly described at paragraph 0031 and is described in the specification in more detail at paragraph 0082. In the following detailed remarks, the Applicant will provide examples from the specification that support enablement of all of the claims; however, rejection of all of the claims is improper. The Applicant respectfully requests withdrawal of the rejection of claims 1-21 for failure of the specification to enable all of the claims.

Also, the Applicant does not understand seemingly contradictory rejections of the office action mailed August 19, 2005 based on both a failure of enablement and anticipation or obviousness. If the Examiner believes that *prima facie* obviousness has been established, such that the process claims are obvious over the references cited in the rejection, then a person of ordinary skill in the art must have a reasonable expectation of success based on the references cited. The primary reference relied upon by the Examiner for teaching the process of making two-way shape memory alloys is the Ho reference, U.S. Patent Publication No. 2002/0043456, which is incorporated by reference in the present application, which only provides an example of a process for making a nickel-titanium film exhibiting the two-way shape memory effect. The other references also fail to teach or suggest any process for producing non-titanium, two-way shape memory alloy films. On the other hand, the disclosure of the present application provides a detailed comparison of the process parameters needed for producing nickel-titanium,

two-way shape memory alloy films and the process parameters needed for two-way shape memory alloy films for four alloy systems having substantially no titanium. Thus, the rejections based on enablement and obviousness are inconsistent. Again, the following remarks will detail the inconsistencies. The Applicant requests withdrawal of the rejection of claims 1-21 for failure of the specification to enable all of the claims.

**ENABLEMENT OF CLAIMS 4-8 AND 20**

First, the specification of the present application details specific examples of the processing ranges useful for making some specific two-way shape memory devices according to the process described in the specification in paragraphs 0079 to 0081. Paragraphs 0079 to 0081 are shown inn Appendix A with processing conditions useful for producing shape memory alloys highlighted in bold. The differences in processing conditions for producing two-way shape memory effect devices using nickel-titanium alloys and these examples of non-titanium-containing alloys is detailed in these three paragraphs. Ranges for the base pressure, pressure during deposition, distance from target to the wafer, film thickness, additional alloying elements, target temperature during deposition, and substrate temperature are detailed for alloy systems comprising gold cadmium [paragraph 0079], iron manganese silicon [paragraph 0080], copper zinc aluminum [paragraph 0081] and copper nickel aluminum [paragraph 0081].

Furthermore, the range of temperatures for the substrate temperature is given as a fraction of the melting temperature (liquidus), which provides the operating range for a wide variety of higher order alloys listed in the application based on these example alloy systems. Since the melting temperaturc for these alloys is known or is easily determined, the specification provides all of the necessary processing ranges for producing two-way shape memory alloys based on the examples with little or no experimentation. If experimentation is needed, it is of the kind done routinely to determine the melting temperature (liquidus) of an alloy system, which is not undue experimentation.

The affidavit of Peter Jardine does not show that the claims are not enabled. Indeed, the affidavit of Peter Jardine clearly states in the last paragraph on page 2 that "...as stated in the specification, processing conditions, such as specific ranges of target temperatures, processing temperatures of the wafer, and vacuum pressures during sputter deposition are needed to make two-way shape memory effect devices." As seen in paragraphs 0079 to 0081, specific shape memory alloy systems are listed with each of these processing conditions specified.

Claims 4-8 and 20 are limited only to the examples provided in the specification, which include the alloy system and each of the processing conditions "needed to make two-way shape memory effect devices." Therefore, claims 4-8 and 20 are fully enabled by the specification.

**ENABLEMENT OF DEVICE CLAIMS**

Second, all of the device claims, claims 12-20, are fully enabled.

With respect to claims 12-14, two-way shape memory effect actuators comprised of alloy having substantially no titanium are fully enabled. Claims 12-14 claim a two-way shape memory effect actuator, comprising: "a film comprising a shape memory alloy having substantially no titanium..., wherein the phase change activates a two-way shape memory effect" and additional limitations. The additional limitations of the claims are completely enabled in specific examples. The specification of the present invention discloses throughout the specification a method of making a film comprising a shape memory alloy, wherein the phase change activates a two-way shape memory effect, and a method of using such a film as a shape memory effect actuator. Working examples are described of titanium-containing, two-way shape memory effect actuators. Paragraphs 0079-0081 detail all of the processing conditions needed to make some non-titanium-containing, two-way shape memory alloy films. Advantages of these non-titanium-containing films are described as making them more suitable for scale-up compared to use of the titanium-containing films. Thus, claims 12-14 are fully enabled.

A working example of a three-dimensional device is shown in Fig. 13 and is described in paragraph 0081. The working example was produced using a nickel-titanium alloy, according to the method described in the specification in detail. Other methods for producing complex three-dimensional devices are described in paragraphs 0081 and 0082. The disclosure clearly states that the examples of non-titanium examples make it easier to produce larger devices using higher base pressures and larger distances between the target and the source, e.g. paragraphs 0079 and 0081. Therefore, non-titanium, three-dimensional structures are easier to produce than nickel-titanium three-dimensional structures. Examples of such structures are provided in Figures 13-15.

**TEST FOR ENABLEMENT**

The disclosure of the present invention meets the test for enablement with respect to all of the claims. The "...standard for determining whether the specification meets the enablement requirement was cast in the Supreme Court decision of *Mineral Separation v. Hyde*, 242 U.S. 261, 270 (1916) which postured... is the experimentation needed to practice the invention undue or unreasonable?" *See* MPEP 2164.01. As stated in this section of the MPEP, this test has not changed.

The following factors must be considered when determining if undue experimentation is necessary:

(A) The breadth of the claims;
(B) The nature of the invention;
(C) The state of the prior art;
(D) The level of one of ordinary skill;
(E) The level of predictability in the art;
(F) The amount of direction provided by the inventor;
(G) The existence of working examples; and
(H) The quantity of experimentation needed to make or use the invention based on the content of the disclosure.

In the specification, the Applicant has provided "considerable direction and guidance" in the specification with regard to the processing ranges for many non-titanium-containing shape memory alloys. Thus, based on the content of the disclosure, at least for the examples of non-titanium-containing shape memory alloys provided in the specification, there is little or no experimentation needed to make or use the invention. Therefore, claims 4-8 and 20, which are limited to the examples provided in the specification, are fully enabled.

From the Examiner's cited references, it can be seen that there was "a high level of skill in the art at the time the application was filed." The remarks of the office action mailed August 19, 2005 rely on the Bement reference to provide an "obvious" choice of shape memory alloys. Bement does not describe any processing conditions for producing two-way shape memory effect devices using alloys of gold-cadmium, copper-zinc-aluminum and copper-nickel-aluminum. In order to establish *prima facie* obviousness, "three basic criteria must be met." *See* MPEP § 2142. This section of the MPEP states that there must be (1) "some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings," (2) "a reasonable expectation of success" and (3) "the prior art reference (or references when combined) must teach or suggest all the claim limitations." Based on the assertion that a person of ordinary skill in the art would find it "obvious" to combine the alloys of Bement, which offers no processing conditions, with the process described in Ho (incorporated by reference in the present application), based on the teachings of Hill that a copper-gold alloy could exhibit two-way shape memory effect, the Examiner must believe that there is "a reasonable expectation of success." The Applicant believes that there cannot simultaneously be a reasonable expectation of success based on this combination of the prior art, and a rejection for failure to enable all of the other shape memory alloys that can be considered similar to one of the examples for which processing conditions are described in detail within paragraphs 0079-0081.

**Nonobvious of Aluminum-Based Alloy Systems**

The processing conditions for producing two-way shape memory effect devices including aluminum are very surprising and unexpected, because "…aluminum is even more reactive than titanium to some of the typical contaminants such as oxygen, water and nitrogen," as discussed in paragraph 0081 of the specification of the present invention. Thus, a person of ordinary skill in the art would expect aluminum-based alloys to be even more difficult to work with than titanium-based alloys and processing conditions to be even more limited. Notwithstanding the well known high reactivity of aluminum to impurities, the Applicant found that the copper-zinc-aluminum and copper-nickel-aluminum systems are comparatively insensitive to impurities, as discussed in paragraph 0081 of the present specification. Therefore, processing ranges are available for these aluminum-based alloys that are less limiting than the ranges available for titanium-based alloy systems. This surprising and unexpected result means that practical devices may be made using alloys of copper-zinc-aluminum and copper-nickel-aluminum.

Arguendo, even if *prima facie* obviousness could be established, a person of ordinary skill in the art would not select an aluminum-containing alloy for use in producing two-way shape memory effect devices. The Ho reference (parent of this present application) teaches that composition is the most critical sputtering parameter and that it depends on how much the alloy constituents react with impurities, according to the following:

> Composition is the most critical sputtering parameter. Typically, small changes in composition occur during sputtering because titanium readily reacts with other materials. FIG. 1 shows the dependence of transformation temperature on Ni--Ti stoichiometry, a shift in composition of as little as 1 atm % can alter transformation temperatures by 100.degree. C. [T. W. Duerig, K. N. Melton, D. Stockel and C. M. Wayman, Engineering Aspects of Shape Memory Alloys, 1990].

Also, the Ho reference teaches at col. 7, ll. 18-25 (and throughout) that an ultra-high vacuum pressure system was needed to produce nickel-titanium shape memory

alloys. A person of ordinary skill in the art would know that aluminum is even more reactive than titanium; therefore, a person of ordinary skill in the art would not consider aluminum-based shape memory alloys to be a good substitute for nickel-titanium in the process describe in the Ho reference. As a result, the use of aluminum-based alloys is nonobvious over the Ho reference.

**Attached Affidavit**

Attached is an affidavit from an expert in the field of copper alloys, including copper-based shape memory alloys. The Applicant believes that the affidavit will be helpful to the Examiner. Entry of the affidavit is earnestly solicited. Dr. L. McD. Schetky, Ph.D., P.E. is highly qualified to present an opinion as to whether a person of ordinary skill in the art of shape memory alloys would believe that alloys based on gold (Au) and copper (Cu) could exhibit the shape memory effect. According to Dr. Schetky, no known combination of Au and Cu exhibits a martensitic phase transformation, and it is well known that such an alloy must exhibit a martensitic phase transformation in order to exhibit the shape memory effect. Based on his many years of experience working with university research programs to develop copper-based shape memory alloys, Dr. Schetky is of the opinion that a person of ordinary skill in the art "***would know that there is no possibility of any combination of Au and Cu exhibiting the shape memory effect.***"

Entry of the Schetky Affidavit and the amendment to claim 15 is respectfully requested.

Withdrawal of rejections under § 112, § 102 and § 103 is respectfully requested based on the preceeding remarks. The pending claims are now in condition for allowance.

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APPENDIX A

EXCERPT FROM SPECIFICATION

[0079] In one example, a heated target facilitates sputter deposition of a **gold cadmium** shape memory alloy film. One advantage of a AuCd over nickel titanium is that the AuCd system is much less sensitive to contaminants such as oxygen, water vapor and nitrogen. Thus, the **base pressure may be greater than $10^{-8}$ Torr**, the distance between the target of a substrate for two-way shape memory effect actuator grade material **may be up to 6 inches** and a two-way shape memory effect **film may be thicker** than a comparable film for nickel titanium. For example, **AuCd may be alloyed with an additional element** to form a ternary shape memory alloy, using hydrogen, copper, silver, zinc or mercury as the third alloying element. Alternatively, higher order alloys may comprise more than one of the elements. The **target temperature during deposition** is selected in a range **from 150.degree. C. to 400.degree. C.** and the **substrate temperature** is maintained between **one-third and two-thirds of the alloy melting temperature**, for example. The melting temperature for AuCd-based ternary alloys ranges from about 190.degree. C. to 400.degree. C. Preferably, the **vacuum pressure during sputter deposition** is selected in a range **from 9 x $10^{-4}$ Torr to 1 x $10^{-2}$ Torr by adding an inert gas.** The rate of deposition increases as the amount inert gas increases. The limited reactivity of Au and Cd to contaminants such as oxygen, water and nitrogen allows **a comparatively high vacuum base pressure during purging** of the contaminants, which may be selected at a vacuum pressure **no greater than $10^{-3}$ Torr.** For example, a range from **$10^{-6}$ Torr to $10^{-3}$ Torr is preferred for the base pressure** during purging prior to introduction of the inert gas. By limiting the base pressure to $10^{-6}$ Torr, the design of the enclosure is greatly simplified compared to ultra high vacuum system required for Ni:Ti SMA. This allows commercial production of much larger devices.

[0080] In another example, the shape memory alloy is selected from an **iron manganese silicon quaternary or higher order alloy** wherein additional alloying elements are selected from hydrogen, boron, carbon, magnesium, aluminum, silicon, phosphorous, sulfur, calcium, scandium, titanium, vanadium, chromium, colombium, nickel, copper, zinc, selenium, strontium, yttrium, zirconium, niobium, molybdenum, ruthenium, rhodium, palladium, silver, cadmium, tin, antimony, tellurium, barium, lanthanum, hafnium, tantalum, tungsten, rhenium, osmium, iridium, platinum, gold, lead, bismuth, polonium, cerium, praseodymium,

neodymium, samarium, europium, gadolinium, terbium, ytterbium, lutetium, thorium, protactinium, and uranium. The **target temperature** is selected to be **at least 770° C.**, and the process **temperature of the substrate** is selected to be in a **range from about one-third to two-thirds of the melting temperature of the quaternary or higher order alloy** composition, for example. The melting temperature for the alloys considered here ranges from about 1,100.degree. C. to 1,400.degree. C. The **vacuum pressures during processing** are selected in a range from **$9 \times 10^{-4}$ Torr to $10^{-2}$ Torr** and **an inert gas is used to generate a plasma**. Iron, manganese and silicon have limited reactivity to the typical contaminants such as oxygen, water and nitrogen. For actuator grade material having a two-way shape memory effect, the **base pressure** during purging should be selected at a pressure **no greater than $10^{-5}$ Torr.**

[0081] In yet another example, the shape memory alloy is based on **one of copper zinc aluminum and copper nickel aluminum**. Specifically, ternary, quaternary and higher alloys are used including hydrogen, boron, carbon, magnesium, aluminum, silicon, phosphorous, sulfur, calcium, scandium, titanium, vanadium, chromium, colombium, nickel, copper, zinc, selenium, strontium, yttrium, zirconium, niobium, molybdenum, ruthenium, rhodium, palladium, silver, cadmium, tin, antimony, tellurium, barium, lanthanum, hafnium, tantalum, tungsten, rhenium, osmium, iridium, platinum, gold, lead, bismuth, polonium, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, ytterbium, lutetium, thorium, protactinium, and uranium. For example, the **target temperature** is selected in a range from **at least 350° C**. The process **temperature of the substrate** is maintained in a range from about **190° C. to 400° C.**, for example. The vacuum **pressure during processing** is selected to be in a range from **$9 \times 10^{-4}$ Torr to $10^{-2}$ Torr, using an inert gas to generate a plasma.** In this example, the element **aluminum is even more reactive than titanium to some of the typical contaminants such as oxygen, water and nitrogen; however, the degree of sensitivity of the transition temperatures and other material properties of the shape memory alloy are substantially less than for titanium in Ni:Ti SMA.** Thus, a **base pressure**



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during purging of contaminants may be selected that is **no greater than $10^{-6}$ Torr** for actuator grade, two-way shape memory alloys.

The Applicant respectfully requests that the amendments to the claims be entered. All of the claims are now in condition for allowance.

I hereby certify that this correspondence is being facsimile transmitted to the USPTO, Examiner John J. Zimmerman, Group Art Unit 1775, (571)273-8300 on the date indicated below

Christopher Paradies
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Enclosure

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